

(a) a chiral ligand  $L^1$  comprising:

(i) a chiral component derived from a chiral diamine, diol, or amino alcohol, said component having first and second chiral centers, each substituted with a group X selected from -O- or -NR-, where R is hydrogen or lower alkyl,

wherein said chiral centers are connected by a direct bond or by a chain of one to three atoms comprising linkages selected from alkyl (carbon-carbon), alkyl ether (carbon-oxygen), alkyl amino (carbon-nitrogen), or a combination thereof,

and, linked to each said group X,

(ii) a heterocyclic binding group  $Cy_N$  comprising a [heterocyclic group] 5- to 7- membered ring having 1 to 6 carbon ring atoms, with the remaining ring atoms selected from oxygen and nitrogen, and having a ring nitrogen atom effective to bind to a metal atom selected from the group consisting of molybdenum, tungsten, and chromium,

wherein said heterocyclic group is linked to said group X at a ring carbon adjacent to said ring nitrogen atom, is optionally substituted with one or more groups selected from alkyl, alkenyl, aryl, aralkyl, alkoxy, aryloxy, acyl, acyloxy, amide, tertiary amine, nitro, or halogen, and may be fused to one or more additional rings,

with

(b) a hexacoordinate complex of a metal selected from tungsten(0), chromium(0), and molybdenum(0),

whereby said complex undergoes a ligand exchange reaction, such that  $L^1$  becomes coordinated to said metal;

wherein said composition is effective to catalyze the enantioselective alkylation of an allyl group bearing a leaving group at its allylic position.

*Rule 5557* (Amended) A catalytic organometallic composition, wherein the composition is the product of a process which comprises

contacting, in a [suitable] nonprotic solvent, a chiral ligand  $L^1$  comprising:

*Sub D3*  
(a) an axially chiral 1,1'-binaphthyl system, said system substituted at its 2 position and at its 2' position with a group X selected from -O- or -NR-, where R is hydrogen or lower alkyl, and, linked to each said group X,

(ii) a heterocyclic binding group  $Cy_N$  comprising a [heterocyclic group] 5- to 7- membered ring having 1 to 6 carbon ring atoms, with the remaining ring atoms selected from oxygen and nitrogen, and having a ring nitrogen atom effective to bind to a metal atom selected from the group consisting of molybdenum, tungsten, and chromium,

wherein said heterocyclic group is linked to said group X at a ring carbon adjacent to said ring